Contribution to the optimization of clarification of cashew apple juices by tangential microfiltration: identification of the foulant fractions and implementation of filterability tests

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CONTEXT

- ❑ To valorize cashew apple in juice
  - ✓ Côte d'Ivoire product 3 million t/year
  - ✓Almost all production is not utilized
  - ✓cashew apple is rich in vitamin C, polyphenols sugars
- ❑ To use Membrane process to clarify cashew apple juice
  - ✓ Cashew apple juice is astringent

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OBJECTIVES

- ❑ To determine the main foulant fractions of cashew apple juices
- ❑ To implement tests of filterability
  Prediction of the filtration performance

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EXPERIMENTAL APPROACH

- ❑ Juice filterability measurements
  - ✓ Specific resistance to filtration (SRF)
  - ✓ Capillary Suction Time (CST)

Lab-scale experiments

- ❑ Membrane permeability measurements
  - ✓ Stabilized permeate flux for defined VRF (Jp)

Pilot-scale experiments

Cashew apple juices

Different fractions of cashew apple juices

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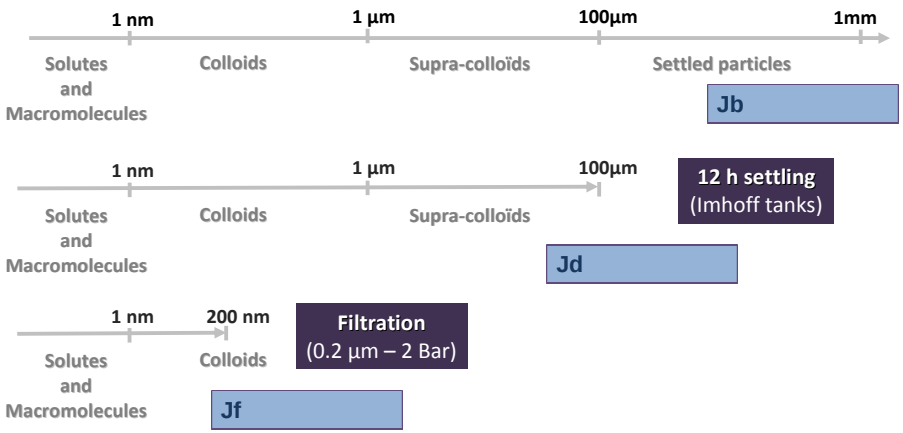
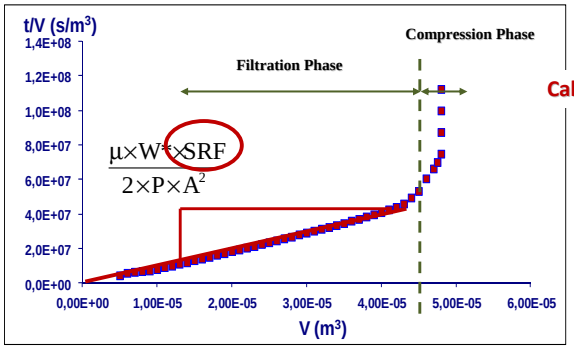
EXPERIMENTAL APPROACH

Raw cashew apple juices

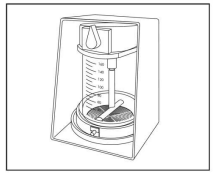


EXPERIMENTAL APPROACH

Specific resistance to filtration (SRF)



Cake filtration 's Law



Stirred Ultrafiltration Cells
AMICON - Model 8010
Cellulose nitrate membrane 0,2 µm – 2 bar

EXPERIMENTAL APPROACH

Capillary Suction Time (CST)

The CST is derived from the time taken to draw a known volume of filtrate from a suspension by the capillary suction pressure generated from standard CST filter paper.

Capillary Suction Time has been established as a reliable method for assessing ***sewage sludge*** *filterability.*
However the CST technique can be used on ***any colloidal aqueous suspension****.*

Triton Type 319 Multi-purpose CST

EXPERIMENTAL APPROACH

Clarification experiments – *Pilot unit and operating conditions*

❑ For clarification, a pilot of micro-filtration was used. It contains four modules connected in series. Each module contained a ceramic membrane of 0.2 µm of pore size.

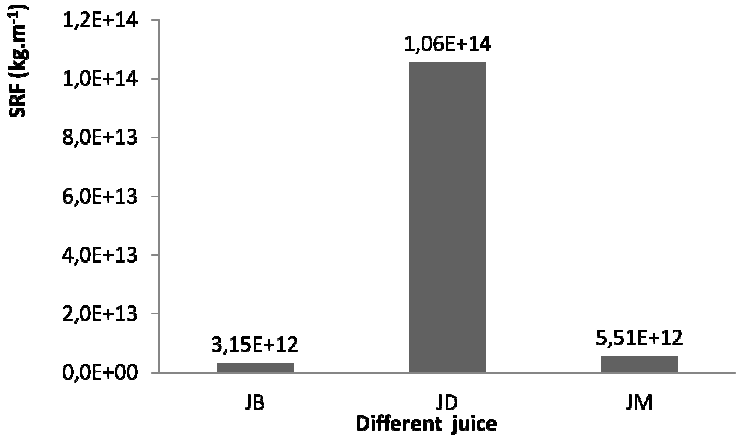
❑ Operating conditions:
- ✓ Crossflow velocity: 6 $m.s^{-1}$;
- ✓ Temperature: 35±2°C;
- ✓ Average transmembrane pressure: 2bar

Pilot Unit

RESULTS – Juice characteristics

	JM	JB	JM
pH	4.05 (0.29)*	3.90 (0,21)*	4.06 (0.15)*
Titratable acidity (g malic acid.kg TSS^{-1})	2.94 (0.08)*	2.61 (0,09)*	2.66 (0.05)*
Total soluble solids (TSS) (g.kg^{-1})	52 (2)*	56 (2)*	56 (2)*
Total Solids Content (TSC) (g.kg^{-1})	65 (2)	60 (2)	60 (2)
SIS (g.kg^{-1})	7.78 (0.46)	3.32 (0.19)*	0**
Tannins (g.kg TSS^{-1})	23.10 (0,13)**	2.1 (0,01)*	0
Alcohols-insoluble solids (AIS) (g.kg TSS^{-1})	3.81 (0.15)**	0.25 (0.02)*	0
Viscosity (mPa.s^{-1})	1.24 (0.07)	1.05 (0.05)	1.13 (0.04)
Turbidity (UNT)	8 033 (907)**	233 (15)*	6 (<1)*
Vitamin C (g.kg TSS^{-1})	15.0 (0.5)	14.2 (0.1)	14.1 (0.7)
Total nitrogen (g.kg.TSS^{-1})	4.04	2.09	1.89

RESULTS – SRF



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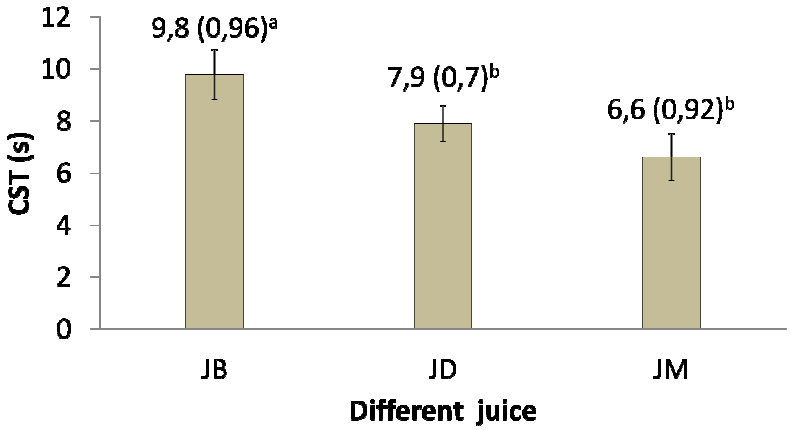
RESULTS – CST



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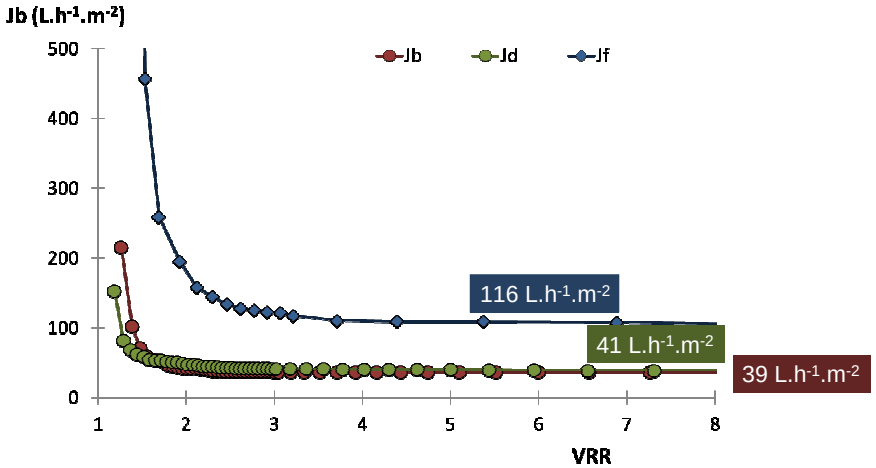
RESULTS – Permeate flux



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- JB (Raw juice) : contains more tannins, total nitrogène, AIS, SIS than JD (Decanted juice) one.
- JM (Clarify juice): not contains tanins, AIS and SIS. Total nitrogène is reduced
- Jp of JM (116 $L.h^{-1}.m^{-2}$), is very raise than JB (39 $L.h^{-1}.m^{-2}$)and JD (40 $L.h^{-1}.m^{-2}$).

RESULTS – DISCUSSION

	JB	JD	JM
Jp ($L.h^{-1}.m^{-2}$) (3<VRR<8; TMP= 2bar)	39	40	116
SRF ($Kg.m^{-1}$)	$3.15\ 10^{12}$	$106\ 10^{12}$	$5.51\ 10^{12}$
CST (s)	9.8 (0.9)[a]	7.9 (0.7)[b]	6.6 (0.9)[b]

- JD has a different behavior of other juice during filtration with cell amicon. Its SRF is very high but its permeate flux is the same than JB.

RESULTS – DISCUSSION

- The JB having the lowest SRF, should in principle have the permeate flux is higher. But this is not the case
- This means that we can not use the filterability tests on Amicon cell to predict the permeate flux of juice

RESULTS – DISCUSSION

- The values of the Capillary Suction Time (CST) of JD and JM are statistically identical. However, the permeate flux are very different;
- We can not use the filterability tests on CST to predict the permeate flux of juices

CONCLUSION

- This study shows that:
  - ✓ simples filterability tests can not be used to predict permeate flux during microfiltration;
  - ✓The colloidal fraction is responsible for membrane fouling in crossflow microfiltration;
  - ✓Crossflow microfiltration removes the astringency of cashew apple juice.